THE NATURAL SCIENCES

THE SAN FRANCISCAN

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THE NATURAL SCIENCES

A HAND-BOOK

PREPARED FOR THE USE OF

PACIFIC COAST STUDENTS.

CONTAINING SIMPLE DIRECTIONS, CONTRIBUTED BY
LEADING SCIENTISTS, TO COLLECTORS AND
PRESERVERS OF SPECIMENS.

COMPILED AND EDITED

FOR THE

SAN FRANCISCAN

BY

FLORA HAINES.

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STUDYING NATURAL SCIENCES.

Close communion with nature is a religion in itself. The Pantheists were not far wrong when they deified the earth and all her products. Every blade of grass has its story to tell of glad, up-springing life, of nourishment drawn from beneath the soil, of the parent root which gives it vitality and strength, of trustful dependence upon the elements. The rocks are records of the world's lost history. Mollusks and fish have each an important place in the great universal plan of life. There are romances in bird life. The humblest insect that flies through the air or hides in subterranean abodes is one of a fairy kingdom whose population outnumbers the human race a million to one, and whose forms of government might serve as models to the first civilized nations upon the globe. The chains of dripping kelp, bits of sponge, empty shells, delicate sea ferns, and mosses, brought in by every incoming tide, betray the secrets of the deep. No one can study nature's open page without turning back to the duties of the day, invigorated in mind and body.

The bodies of our California children need attention. We are rearing a race of beautiful, rosy cheeked little people of an almost phenomenal physical development, but who have no more real stamina or endurance than

some large-petaled, glorious flower. They have the indolence of tropical races without the vitality. When disease attacks them it is like a sudden flame, which burns more fiercely and more surely because it finds such a large and splendid organization to feed upon. We will not bring forward tables of comparative mortality to support this statement. It is sufficient that no other city in the world, with San Francisco's salubrious situation, presents such an appalling death-rate among children. Wrong living, wrong training, are the causes of many of these deaths.

The young people of California, and especially of San Francisco and its vicinity, are constitutionally opposed to exercise, and this indisposition increases as they approach mature manhood and womanhood. The average young woman of San Francisco will take a street car rather than walk a dozen blocks; the average young man holds physical prowess in contempt, and allows his splendid muscles to remain undeveloped, while he cultivates ball-room graces or prepares himslf to be a weak represenative of some learned profession.

The evil is not one which can be amended in a day, but *The San Franciscan* knows of no better remedy than to encourage the prosecution of studies which will take our young people out of doors and on long tramps over the surrounding country. Such exercise, when it is not common custom, will never be observed as a matter of habit; but place some definite object in view, and it is astonishing how distances are annihilated, the mind is aroused to activity, the hill and valleys and seashore are invested with new interest, and healthful weariness is regarded as a light toll to reach the ends in view.

The Natural Sciences alone promise to meet this requirement.

Aside from the intellectual and physical benefits to be derived, there is a third consideration, which holds a deep significance in its bearing upon important social problems. The preparation of specimens, their arrangement in museum, cabinet, or herbarium, the study which determines their classification, are labors which can be pursued to advantage nowhere but at home. The growing tendency of young as well as old Americans is to cut loose from home ties. Whatever tends to concentrate the interest of the young about their home or to add to its attractions, will bring a sense of peace and security into many troubled hearts. There is nothing which invests a home with such distinctive character and lends it such a charm to a person of intelligence as the presence of an interesting cabinet or of a miniature museum. It is surprising how fast specimens can be accumulated when once a beginning has been made. By carefully collecting a sufficient number of duplicates of the specimens to be found near home, the young student will find no difficulty in exchanging with others who are interested in his particular study and who live in the most remote portions of the world. For instance, any one who takes the trouble to collect the varieties of sea shells found in and about San Francisco can, within six months, be in possession of a collection numbering many thousands, including the beautiful forms of mollusks found in the South Sea islands, in Australia, along the shores of China and Japan, on the Atlantic coast, and from the Mediterranean sea. The only expense involved will be in paying the freight upon the shells one way, which, as they are light and

fragile things, is a matter of comparative insignificance. If the collector happens to have any acquaintance with ship owners or sea captains, it is usually possible to find relief from even this slight expense.

The young student is at first omnivorous in his tastes; the plants, the animal life, the rocks, interest him alike. By and by he realizes the impossibility of thoroughly finishing even one line of research, and willingly limits himself to some favorite branch. Even in the beginning he needs the aid of older heads; and to this end a number of prominent scientific gentlemen have prepared, in their separate specialties, simple and comprehensive suggestions for young beginners, which are written with special reference to the natural resources of our state.

THE EDITOR.

The publishers send out this little book in the hope that it may arouse new interest in a fascinating field of study. It is unnecessary to point out the unusual inducements which our state presents to those interested in any branch of scientific study. California is not yet one half explored, and many notable discoveries can be insured to the earnest collector. A department devoted to the Natural Sciences will be regularly conducted in *The San Franciscan*, by the editor of this Hand-book, where interesting information and valuable suggestions to students will be published, from week to week. Any one who signifies an interest in the subject, by simply sending in their name for enrollment, will be entitled to the benefit of correspondence or of sending in questions to the "Query Box." Furthermore, a special arrangement has been made with leading local scientists, by means of which those who have specimens of any kind which they wish identified and classified can have them named by the best authority by simply bringing them to the office of *The San Franciscan*, No. 420 Kearny street. Such specimens will be received between ten and twelve o'clock every Saturday forenoon. They should be accompanied by a card or slip of paper bearing the collectors' name, and, except in cases of unusual interest and rarity, they will be returned the following week.

BOTANY.

HINTS TO COLLECTORS.

[BY J. G. LEMMON.]

EQUIPMENTS.

1. *The Portfolio.*—Provide yourself with a large folding case, twelve by eighteen inches; the cover of a large ledger or a piano instructor will answer very well. Half fill it with folios of soft white paper of nearly the same size, laid in loosely and not fastened to the back. Instead of white paper, folios can readily be obtained by cutting the binding-threads of *Harper's Weekly*, or other such magazine, and separating it into folios—that is, sheets folded into two leaves. Half of them will have the illustrations on the inside; reverse these so the plants to be put on the inside will be less injured by the ink. Put in the portfolio with them a quantity of the dryers, next described.

2. *The Dryers.*—Provide a quantity of bibulous paper, in thick sheets, of the size of the portfolio. A kind of paper used for carpet lining is suitable, but the best is manufactured expressly for the purpose, by S. E. Cassin's naturalists' depot, Boston, Massachusetts. For beginners, common newspapers, folded to suit, will answer. Before using, these dryers are exposed to the heat, gener-

ally by spreading in the sunlight, then piled in a pack for use.

3. *Implements.*—For short trips on level ground all that is necessary is a strong knife, suited to digging the roots or bulbs of small plants, but sharp enough near the hilt to cut twigs of bushes and trees. This knife is carried in a sheath fastened to your belt. For long trips, or mountain climbing, strong but light boots or shoes and a long, stiff, light staff provided with a crook, or, instead, an umbrella with a hooked handle may be found useful for several purposes; but instead of either a botanical "digger" is often found the most useful. This is formed like a miner's pick, but smaller, ten to fourteen inches long, and with a hoe on one end. If furnished with a long, slim, strong handle, it will serve instead of the staff described. In addition, you carry a strong haversack, filled at the start, if you are wise, with substantial food, to be replaced with desirable bulbs, specimens of bark, acorns, cones, etc., as found.

Instead of the portfolio, for short excursions, some collectors take a tin box (vasculum), closing tightly, and provided with a handle and strap for carrying on the back. Plants of a coarse nature may be so carried for several hours, by occasionally sprinkling them with water, but delicate and minute plants should be put in papers at once. You are now fully equipped.

HOW TO COLLECT.

Arrived at the locality of the plants desired, gather them carefully, roots and all, of the small ones; choose a shade, if convenient, and open your portfolio at the edge of the last flowers inclosed. Open the empty folios,

one after another; place within each one or more plants in a natural shape, cleaned of soil or dried leaves and stems, the roots or larger parts being disposed near the corners or otherwise, so that as the pile increases it will rise up squarely. The flowers should be open, and show, if possible, their essential organs—the stamens and pistils. Make them face outward, either by drawing the plant gently downward a little, or, if it droops, the open facing can be better accomplished by touching the lower petals or side of the flower to the paper, and gently pushing upward. When dry the plant can be turned. If possible the specimen should show fruit as well as flowers.

In case the plants are thick or very succulent, it is often advisable to split them open and spread them, and even to cut away interior parts. Drying may also be expedited by dipping the plants momentarily in hot water before placing in folios. Dead leaves and tufts near the roots may generally be removed without loss of characters, also sections of too heavy stalks. Grasses are generally doubled and held in place by strings, or by passing the bent culms through a slit pierced in a small piece of paper.

WHAT TO COLLECT.

Plants, to be valuable as botanical specimens, must show all their characteristic parts, retain their natural color, as nearly as possible, and be capable of handling for examination. These ends are best accomplished by careful selection of specimens and the speedy extraction of their juices under pressure between papers.

Beginners generally err in several of these particulars, and much hard work is wasted and the collector often

seriously discouraged. The writer lost the labor of many months for want of proper instruction.

Select plants of medium size, if possible containing all the organs complete and in a forward state, with mature fruit, or nearly so; if not possible, then parts of the plant illustrating its entire organs, habit, uses, etc. These, collected at the end of the season and presented in a series, form acceptable specimens, especially if accompanied by copious notes recording locality, habit of growth and time of collecting. Avoid the too common practice of collecting merely blooming plants. They are only valuable as beautiful ornaments. "Too young" are the words most frequently found in the reports of determinations received from Dr. Gray by the anxious beginner in botanical research.

If the specimen is necessarily too long for the folios, double once or twice lengthwise of the page. Be sure that every part is included within the limit of fifteen inches, so the plant may be admitted to an herbarium or permanent collection of dried plants twelve by fifteen inches being the established standard of dimensions in all noted herbariums.

PRESSING THE PLANTS.

Arrived at home, take out from the portfolio all your folios of plants; assort into two or more classes, the most succulent in one class, the next juicy in another, then putting the small or nearly dry ones in still another class. The latter, with the large family of grasses and the ferns, will need much less care in pressing than the first classes. Have ready an evenly-piled lot of dryers. Place one on the table, or whatever space you allot for drying;

place a folio of plants upon it evenly, looking perhaps to see if flower and leaves show to the best advantage, and carefully correcting misplacements, if any. So continue until all the plants are piled up evenly, each class described above by itself for separate subsequent treatment. Put a short board upon each pile and weight it down with a stone, or, better, bags of sand. For the smaller, dryer plants, weights of a few pounds are sufficient; for the larger, more succulent plants, the pressure should weigh thirty to fifty pounds; but never crush the flower by too heavy weight.

It will hasten the extraction of moisture very materially by placing two or more dryers between the very succulent plants. Remember that the more speedily this is accomplished in this manner the brighter the colors will remain and the tougher will be the specimen.

CHANGING DRYERS.

Now comes the toilsome, monotonous, uninteresting part of botanical work. It is best to learn to do it deftly —mechanically, as it were,—so that the general interest in floral research may not flag.

Coax some one to assist you, by liberal promises of large rewards, if necessary, and if your conscience will allow. Remove the weights from your plants and prepare to change the dryers. This should be done as often as once a day or oftener for the succulent classes, but the others may remain longer untouched. With a knife-blade or other pointed instrument in the hand, raise the edge of a folio of plants; grasp and remove it to a vacant space on the table, while your assistant snatches away the dryer beneath and casts it out into the sunlight, or

piles the lot up to be sunned afterward as a distinct job. If you have plenty of dryers you can employ another assistant, by having dryers placed between each of the folios as you place them for a new pile. This slavish work can be done very speedily after a little practice.

At this first changing of dryers, perhaps the grasses, ferns and other little things may be found dry enough for storing away. A little practice, also, is necessary to determine this. As a rule, when the folio is found dry and the plant will bear handling, with no green or juicy parts remaining, it may safely be packed away. This do in smooth, even bales, or place in suitable boxes, laying a board and a light weight upon them. Before thus storing the plants they should be consolidated as far as convenient, the specimens of the same species or family united, and the folios all evenly filled. At this period reserve good, full specimens of such plants as you wish determined, and put them aside.

The writer arranged his duplicates into their respective families and species and placed them in large books, now forming very attractive, portable herbariums. The plants are fastened to the right-hand pages of each leaf, by narrow pasters of white paper, holding the plants firmly at several points. Strong, thin tissue paper, gummed on one side with mucilage, then cut into strips, and applied by moistening the ends with the tongue, will answer, but strips of court-plaster are best of all. Near each specimen is fastened, by gumming one end, a narrow label, bearing the number, name and namer of the plant, and often the locality and habit.

SENDING PLANTS BY MAIL.

Plants, either alive or dried, are regarded as third-class

matter, and admitted to the mails under certain conditions. The package must be under a certain weight and size, must injure no other matter, and be so wrapped as to disclose its contents to the satisfaction of the post officials, and must contain no written words except the labels. The penalty for a violation of these regulations is twenty-five dollars. Put your dried plants, each bearing its number, into clean papers, of a size sufficient to contain all, place beneath and above them a stiff paste-board—paper-box covers will do—of suitable size; inclose all, if you wish, with a wrapping paper, leaving one end exposed for inspection, and tie tightly with twine; address plainly, and put on stamps equal to one cent for each ounce. Accompany the package with a letter of announcement, and notes of the plants, if possible.

To send live plants, choose the autumn season, when the plants are asleep; wrap them with gutta-percha; make the package nearly air-tight; surround the mass with moss or fine-thread lichen dipped in water, then squeezed perfectly dry, to the thickness of an inch or more; then wrap loosely with strong paper: tie with twine, leaving an aperture for inspection as before.

THE "EXCEEDING GREAT REWARD."

By the aid of the long waited for *California Flora*, now at hand, issued in two volumes, price six dollars each, from the Cambridge University, by Dr. Asa Gray and a large corps of assistants, the varied and rare flora of this most interesting Pacific slope may be determined. Now a pure and lofty pleasure may be experienced in the recognition of the characters, and the learning of the proper scientific names of the beautiful gems lavished

about our pathway. So difficult are some of our mountain ranges of ascent, and so certain are isolation and peculiar climates to produce distinct specific characters, that almost every peak and secluded dell has its special flora.

I will not attempt to describe the ecstasy of joy that thrills the soul of the true lover of nature, when, after a long and toilsome excursion, he is informed for the first time that he has enlarged the realm of knowledge by the discovery of a new plant, and that his name is to be associated with it in the beautiful, uncorrupted Latin language, to be uttered by the scholars and scientists of every civilized nation throughout all coming time! But missing this honor, what is equally as laudable is sure to be achieved, that is, increased knowledge of little-known plants.

The chief reward, however, is often found in the increased vigor imparted to both body and mind by the arduous pursuit of botany.—*Published, by permission, from the Rural Press.*

Mr. Lemmon appends the following notes upon ferns and grasses, prepared especially for this publication.

FERNS.

The lovely appearance and interesting character of the large family of ferns, make them a most fascinating study. Their variety and number on the Pacific coast is not yet absolutely determined. In 1882 the number of known species was eighty-one, with about twenty marked varieties. Extensive botanical researches made since that date by the writer with his wife, along the southern border, resulted in the addition of a dozen other ferns and

twice as many marked varieties. Other explorers have added a few new ferns.

Since the publication of a pamphlet, "Ferns of the Pacific Coast," issued in 1882, extended observation has suggested a new method of presenting to the student of botany or the lover of nature generally, an easily acquired knowledge of these most interesting plants. I have discovered that all of the descriptions, distinctions, comparisons, classifications, etc., of ferns, fall naturally into sets of three or some multiple of three. By a little painstaking, tablets or formulas of characters, comparisons and the like can be arranged, which, striking the eye by their uniformity and arresting the attention by the numerical reiteration, help to retain facts in the mind which, presented in the usual manner of text-books and manuals, are found to be difficult of remembrance.

GRASSES OF THE PACIFIC SLOPE.

The grasses of the Pacific slope which have lately received large accessions, have never been treated in a brief and popular way, I believe, though the species found in California have been elaborately described by Professor George Thurber, in the second volume of *Botany of California;* a large work, costing six dollars, and well worth the price to advanced students, but too recondite for beginners, besides not covering the whole of the naturally homogenous territory embraced in the region west of the Rocky mountains and north of Mexico; that is, the Pacific slope.

Owing to the large number of genera (120), and of species (675), within the limits of the United States north of Mexico, the study of the order of *Gramineæ* is attend-

ed with much difficulty, and the labor especially increased by the fact that some of the characters relied upon for distinguishing genera and species, are so minute as to be detected only by the aid ot a magnifying glass.

Of this large number of United States genera, eighty are found on the Pacific slope, with about two hundred distinct species and a large number of marked varieties.

So beautiful, and withal so useful, are the most of the family of grasses, that the lover of nature as well as the practical man should endeavor to get acquainted with them; and it is the duty of special students of botanical science to aid them by simple and popular descriptions.

SOME VALUABLE NOTES.

Mr. Edward Lee Greene, Instructor of Botany at the University of California, a gentleman generally recognized as one of the foremost botanists on the Pacific coast, kindly furnishes a few supplemental notes for the guidance of beginners, saying:

"To defend specimens from the inroads of destructive insects, corrosive sublimate, dissolved in alcohol, is the only sure remedy. The specimens should be sprinkled with this wash, and afterwards dried. This is a dangerous compound, which children should not be allowed to handle.

"There are no books treating of the California flora, which are suitable for beginners. Dr. Behr's book, which is a very interesting and valuable publication, includes

descriptions of genera only, not descending to species. Mr. Rattan's *Popular Flora* is better; but even that is incomplete and fragmentary.

"The study of botany presents a wide and fascinating field to the young collector. On the peninsula of San Francisco there may be found perhaps two or three hundred different species of plants. At Oakland and Saucelito, by searching places where the soil and climate differ, at least twice as many more may be gathered."

MARINE BOTANY.

[BY MRS. J. G. LEMMON.]

When one wanders along the ocean-shore he is threading, it may be unconsciously, the border line between the two immense divisions of the vegetable kingdom, the one terrestrial and visible, the other marine and for the most part invisible. It happens also that the plants of these two divisions reach their maximum size near this border line; the land plants, on the one hand, diminishing in size as they ascend the mountain heights, the marine plants, on the other hand, no less lofty and grand, diminishing to minute forms as they descend to the ocean's depths.

On all tide-washed shores there are three distinct regions or vegetable zones for living and growing plants. These zones naturally result from the phenomena of the tides. The upper zone is reached only by the high tides, twice every lunar month. Here will be found pools, it may be deep ones, and, as they have their waters changed only at long intervals, their plants must necessarily be different from those of the other regions to be described. The median zone is reached by every tide that flows, and so is flooded and again exposed twice every twenty-four

hours. Of course this frequent change of the waters must affect the growth of the middle-zone plants, and so produce in the pools its peculiar vegetation.

The third or lowest zone is the space along the ocean that is rendered shallow by every receding tide, but never left entirely exposed. This shallowness gives the best conditions for the largest plant-growth. From this point, gradually, they diminish in size to simplest and minutest forms as the mid-ocean depths are approached.

The plants of these zones are generally distinguished by a color peculiar to each, and indicated by the names of the three grand divisions of marine algæ—*chlorosporæ* or grass-green, *rhodosporæ* or red, and the *melanosporæ* or olive-brown, corresponding nearly to the three zones respectively.

How to dress and what articles necessary for an excursion to the sea-shore for collecting plants:

First, never go alone; there is some danger, when one is deeply interested, that an incoming wave may catch you unwary, and in its rapid and strong sweep take you out to sea, unless warned of approaching danger by your companion.

With flannel suits, rubber boots and gloves, close caps or hats, a strong staff, five or six feet in length, with a wire ladle or skimmer attached firmly on one end, a few cloths or papers, a rubber bag or large-mouthed glass jar, a pocket microscope, pencil, knife, note-book, and a basket large enough to hold the articles and collection of plants, you have all that is necessary as a simple outfit to make the richest and best possible collections.

On the Pacific coast, collecting may be done through each month of the year, with signal success. The climate is

particularly favorable, especially as compared with the Atlantic sea-board. Different species are maturing during every month, but the most luxuriant growths and finest fruiting specimens are found at the beginning of May and on to the first of August.

Plan to reach the shore as the tide is going out, taking advantage of the extreme low tides that come at about new and full moon, as many rare and choice species are found at the lowest run of the tides and in the shallow water beyond. As the tide turns and is coming in, you can also retreat on middle ground, searching carefully the water pools for fresh living plants, as well as for delicate and often rare transported specimens. Gradually, as the tide has come in, you will have moved to the upper shore-overhanging reefs. Along this region or upper zone you will find the coarser and light-green algæ; and, where the tide currents rush in and out, many deep-water forms, beautifully displayed as they wave back and forth in their accidental locality. After every high tide has ebbed, may be seen a large dump or "windrow" of material that should never be slighted, for in this mass you will find all sorts of treasures with their various shades of color, depending somewhat upon the exposure to direct sunlight. Here may be found portions at least of many deep-water plants. The tide pools and rocks, at low tide, will furnish the living plants of that special locality, in their homes, and, as an advantage over the drift and windrow mass, furnish the best opportunity to watch their growth. Peer into crevices, scan the pools from the lowest shore to the highest, climb the rocks, search everywhere, and collect as many kinds as sharp eyes and diligence will allow.

Let us suppose that we have returned from our sea-shore botanizing, after having searched all the tide-pools possible, at the lowest ebb—in the middle space and almost dry upper shore, the reefs, and overhanging rocks, taking generously all sorts from the big windrow; and that you may be better qualified to determine the habitat or locality of your plants at subsequent study and examination, making careful notes as to where found.

At this stage of proceeding a few simple articles are required, such as a pair of pliers, to assist in handling the plants in the water during the floating out; scissors, for trimming unnecessary branches that might be bushy and in the way, besides, would not look well when mounted; then, again, parasites or plants growing upon the particular species to be mounted should be cut off; a pen-stock, with a needle driven in and the point blunted—this to assist in arranging the delicate, hair-like points of some of the fronds; two or three large white dishes, like deep soup-plates or platters, to fill with salt water and place the plants in, where they may be plainly seen as they are being floated out; two dozen or more blotting-pads or drying paper, 12x18 inches—these to absorb moisture while the plants are under pressure; the same number of old cotton or linen cloths, the same size, to lay directly upon the plants as they are ready for the press; half a dozen panes of glass, about 8x10 inches, to float out the coarse specimens upon, when they need a slight draining and drying before mounting; also card-board, or white paper with a fine surface, but strong and tough; get unfolded and unruled 28 or 30 lbs. demy paper, 16x21 inches. By quartering this a fine uniform size 8x10½ inches is gained; or, by halving these to 5¼x8 inches, another excellent

medium size is gained, large enough for the majority of plant specimens, and a good size for albums or reference book; two smooth boards, 16x28 inches or 12x18, to place beneath and above the plants as they are put under pressure for drying; two bags of dry sand, of 15 to 20 lbs. weight each, using one bag at first, and after changing the dryers adding the other, as heavier weight is then needed for final pressure; last but not least is a good stand-microscope. This may be termed your double eyes, and should be your almost constant companion in collecting, preparing and studying the specimens. Especially is it invaluable in selecting the fruited specimens, for upon finely fruited plants depends the principal value of the collection. They are sure to be beautiful, and a never-ending delight to the student who determines to learn the hidden beauty, wonderful construction, physiology, and manner of growth of this world of ocean vegetation.

Sort out as well as you can all plants that look alike, and place them in separate dishes filled with salt water. Never use fresh water to float out the plants, as it makes them tender and they lose their color. With the magnifying-glass decide upon your best fruited specimens. These may be easily detected. Minute brown or yellow dots—the fruit—may be seen disposed in various places, according to the species, afterward to be learned. These fruit dots are sometimes near the edges of the fronds, within the surface, scattered over the entire surface, at the joints of some species, on the tips of the fronds, and in other places.

These best specimens should now be floated out carefully, by the deft use of fingers as well as by the blunt needle. Push a sheet of the mounting-paper under the

specimen, in the water, all the while spreading out the frond carefully as it floats quietly in the water. Now lift the paper with the plant out of the water, aslant, draining the while, till fully brought from the water. After the final adjustment of all the branchlets, lay the specimens aside, covered by a double cloth, as ready for pressing. In this way prepare enough to be covered under one dryer. This may be repeated till you have enough for a dozen or more dryers, if you are sufficiently expert to prepare this number before the first specimens become too dry and begin to curl.

A quantity for pressing and drying should be arranged thus: First, for their reception place, one of the smooth boards; second, a dryer; third, specimens on the papers—enough to cover the dryer; and fourth, the double cloth. Repeat in this order till all are placed in position, then lay on last a dryer and the other smooth board, and last of all weight down with one of the bags of sand. Let them remain under this pressure twenty-four hours, then take out the dryers. After thoroughly drying and sunning or heating them, return them to place as before, and add the other bag of sand. This one change, as a rule, is enough to extract all moisture and perfect the work of pressure. Sometimes a heavy, succulent stalk requires three or four days drying and pressure. If the dryers are changed daily, or even twice per day, the true color of the plant is better retained. When the collector has finished this introduction to the study of marine botany, if he will but persevere with the microscope, together with a hand-book of description, names and classification of the plants, he will find that all this fascinating preparatory work is but tame and monotonous as compared to the de-

lights of intricate study and research. Perchance he may discover new species, thereby enrolling his name among the real contributors to original research and discovery—no mean ambition.

A simple hand-book of the marine algæ adapted to the Pacific ocean flora has long been needed by those who would become acquainted with this class of interesting plants. Such a work the writer contemplates issuing soon, which, it is hoped, will bear especial aid to the young student in the study of marine botany.

OAKLAND, California, December, 1885.

In concluding the charming contributions contributed by Professor Lemmon and his wife, the editor feels a strong desire to make the readers acquainted with the character of these earnest and united workers, together with some idea of what they have accomplished.

Mr. Lemmon was a soldier of the late civil war—a member of the Fourth Michigan cavalry,—one of the three years' volunteers who enlisted in the service of their country at the breaking out of the rebellion. He was a gallant soldier, who declined promotion, believing that he could serve the cause better in the ranks. He spent six months as a prisoner in Andersonville and Florence, and came out at last with his naturally fine constitution shattered—an emaciated wreck of manhood, being one of one hundred and seventy-five out of five thousand prisoners who were able to stand upon their feet, many of whom died of joy at tidings of their liberation. He went back home to die. His own mother, viewing his terrible condition of mind and body, afterward confessed that she

hoped he might soon die, seeing before him nothing but a tragical experience if the feeble spark of life should be preserved. In 1866 he came to California. At this time he was unable to walk more than a few paces without exhaustion, and recognizing his hopeless state, had lost all interest in every thing about him. A physician who chanced to meet him at a little mountain settlement was the first one to suggest the hope of his restoration. He put the young man on horseback. Riding slowly about, unable to sit upright, going a rod or two the first time, a little further the next, and so on from day to day, the feeble soldier began to find diversion in observing the forms of vegetable life about him, and occasionally gathered a plant or two. In this way a botanical enthusiasm which he had embraced in early boyhood gradually revived. This circumstance saved his life. As a dear friend expresses it, "he drew close to nature's heart, and it nursed him and took care of him."

It was not long before he became recognized as one of the most devoted botanists on the Pacific coast. He traveled from place to place, gathering and sending East for identification the species he was unable to determine. In the Centennial year he met Miss Sara Plummer, a young eastern lady who had come out to Santa Barbara to regain her health, after trying the damp Florida climate in vain. Their mutual love of plants led them together, and four years later they were married, and have since prosecuted their researches together with the most notable results. The name of Lemmon is quoted wherever the North American flora is mentioned, and out of the numerous new plants they have discovered, many species and two genera bear their names. Both are still possessed of

delicate constitutions, and are confirmed invalids. Professor Lemmon can not ascend an ordinary flight of stairs without stopping to rest, yet together this loyal couple have patiently toiled over the scorching deserts of Arizona and New Mexico, climbed the rugged mountains of Nevada, and searched the hills and valleys of the Golden State. As an illustration of the practical success they have achieved, it may be mentioned that one of the United States government expeditions, which included five botanists, during three years' travel under military escort, going through the same field which the Lemmons chose, discovered fifty new species, while Mr. and Mrs. Lemmon together, without escort and working in the face of every disadvantage, discovered one hundred new species in the same space of time. There is a lesson in this little account which healthful, active young persons would do well to consider.

"I don't think, dear, that united we are little more than equal to one able-bodied person, do you?" said Mrs. Lemmon, turning to her husband, as the editor sat conversing with them in their quaint little back parlor—half sitting-room, half museum, and redolent with the fragrance of spicy herbs.

"We don't begin to be that! we don't begin to be equal to one sound, healthy person," corrected the professor, with such quaint candor and sad certainty as to provoke at the same time a smile and a tear from the listeners.

NATIVE WOODS.

Mr. H. S. Durden, Secretary of the State Mining Bureau, has kindly contributed the following timely and comprehensive suggestions to collectors of native woods. Our contributor is himself a practical collector, and has a beautiful and extensive variety of woods, gathered in his occasional days of leisure and by the most indefatigable search. These he has added to from time to time by exchange with people who are interested in the same subject elsewhere. The simple directions which he gives, and the suggestions regarding the localities where special varieties are to be found, are the condensation of his own experience, and will spare the young collector many fruitless journeys and disappointments.

NOTES ON THE COLLECTION AND PRESERVATION OF SPECIMENS OF NATIVE WOODS.

Quite a number of native trees and shrubs can be found, by the diligent searcher, within a short distance of the city. A long, narrow-bladed saw will be found the most convenient tool with which to cut specimens. Select one which is thick on the toothed edge and thin at the back; it will not be so apt to "bind." Those unaccustomed to the use of a saw will find a little grease of any kind applied to the saw a great help in getting through any of the

harder woods. A carpenter's compass-saw will do very well. It will seldom happen that any desired specimen will be found exactly vertical; and in cutting out pieces of limbs or stems of bushes that lean over, it is best to cut partly through on the *under* side first, then cut on the upper side, and the section will break off without tearing or splitting. Specimens should be cut up to near the desired sizes soon after being collected, then soaked in water for two or three weeks, or boiled for an hour or two, and then dried slowly under a weight. When dry they can be planed off and polished.

I will now indicate some of the localities in which the different varieties will be found, of as large size as they usually grow:

On the peninsula of San Francisco—Lobos Creek: Myrtle, *Myrica Californica;* toyon, *Hetromeles arbutifolia;* willow, *Salix lasiolepis;* dwarf live-oak, *Quercus agrifolia;* and some small shrubs, honeysuckles, etc.

From Piedmont to top of Contra Costa range—Mountain mahogany, *Cercocarpus parvifolia;* service-berry, *Amelanchier alnifolia;* wild cherry, *Prunus demissa;* chinquapin, *Castanopsis chrysophylla;* willow, hazel, etc.

Strawberry Creek, behind the University, over to Wild Cat Creek—Leatherwood, *Dirca occidentalis;* dogwood, *Cornus pubescens;* Baccharis, *Baccharis;* alder, *Alnus rubra.*

Saucelito—Evergreen huckleberry, *Vaccinium ovatum;* hazel, *Carylus rostrata;* satin-tassel, *Garreya elliptica;* Oregon grape, *Berberis;* wild coffee, *Rhamnus Californica.*

Phœnix Gulch, up from Ross Station, N. P. C. R. R.—Elder, *Sambucus glauca;* ash, *Fraxmus Oregona;* maple, *Acer macrophyllum;* box-elder, *Negundo Californica;* white oak, *Quercus lobata;* black oak, *Quercus Kellogii;* buckeye, *Æsculus Californica;* tan-bark oak, *Quercus densiflora;* mountain lilac, *Ceanothus,* two or three varieties; alder, *Alnus rubra.*

Mount Tamalpais—Nutmeg, *Torreya Californica;* manzanita, *Arctostaphylos*, two or three varieties; satin-tassel, *Garreya elliptica;* golden-leaf canyon live-oak, *Quercus chrysolepis;* service-berry, mountain mahogany, chinquapin, etc.; *Biglovia arborescens*, *Quercus Wislezenii*, and others; laurel, *Oreodaphne Californica;* madrona, *Arbutus Menziesii*. Alder, willow, buckeye, mountain lilac, hazel, etc., will be found generally distributed in most of these places; but the leatherwood, satin-tassel, chinquapin, nutmeg, mahogany, wild cherry, service-berry, and canyon live-oak are very much localized. Coast live-oak, *Q. agrifolia*, Monterey cypress, *cupressus macrocarpus*, and Monterey pine, *Pinus insignis*, can be cut as easily right in the city as anywhere. Poison-oak, *Rhus diversiloba*, will be found anywhere, and when of good size makes very pretty wood, but care must be exercised in cutting it.

H. S. DURDEN.

FUNGI.

[BY DR. H. W. HARKNESS.]

Of the lower forms of vegetable life, fungi must ever occupy the most prominent position, not only for their economic value, but also for their destructive qualities as well. Fungi are noted for their rapidity of growth and their extensive distribution. No other plants grow with such rapidity, as instanced in the mushroom and the puff-ball, which spring up and arrive at maturity in a single night.

Many species are valuable for food, of which the mushroom is most familiar as a table delicacy. Another, the puff-ball *(Lycoperdon)*, is a still more delicate and palatable article of food, while many of the despised toad-stools may serve as table delicacies to those who will take the trouble to identify them and to separate them from those which are known to be noxious. With but little trouble one may learn which are edible and which are poisonous, and in this way may utilize a portion of the hundreds of tons which are now annually wasted.

There are several species of fungi which are a terrible pest to the farmer. The most notable is the red rust *(Puccinia graminis)*, which greatly impairs and sometimes entirely destroys the wheat. This appears, after a

foggy morning, as a brown or reddish rust attached to the stalks and leaves of the wheat, and by cutting off the nutriment of the plant materially diminishes the yield of wheat.

Another species *(P. infestans)*, causes the blight in the potato, often destroying a whole field in a single night. This fungus, so minute as to be invisible to the naked eye, has been the cause of a great famine in Ireland, and has caused many millions of dollars damage in other countries.

Still other species produce the pea blight, the rose blight, and a vast number of forms of vegetable pests, while the trees of the forest are by no means exempt from the attacks of these insidious foes.

The giant spruce of the mountain forest is often destroyed by the stealthy encroaches of a fungus *(Dœdalia vorax)* which finds its way into the trunk of the living tree, and in a few years accomplishes its destruction. The beautiful firs also yield to the same morbific influence, and are killed by the thousand.

Another species *(Merulius lachrymans)* attacks the fallen monarchs of the forest and soon reduces them to dust. In this instance the fungus seems to serve a beneficent purpose, as by this means the fallen wood is resolved into its original elements and is turned to use in fostering the growth of other plants.

The number of species of fungi now known and described must be nearly or quite thirty thousand, and there are, no doubt, enough which are still practically unknown to swell the number to eighty thousand or more, so that the subject presents a wide field for study and discovery.

The student is recommended, in gathering specimens, to keep that portion of the wood or bark or plant to which the fungus is attached. Large fungoid growths should be carefully dried for preservation.

Cook's *Hand-book of Fungi* is the only available authority which treats upon the subject.

FRESH WATER ALGÆ.

[BY DR. H. W. HARKNESS.]

This family of plants embraces all of those forms of vegetable life which we observe in inland waters. They are found in almost infinite variety in the green scum floating on the surface of stagnant pools, as well as in those silken filaments which are found so abundantly in running streams, swaying backward and forward in the changing current. They fringe the pebbly shore with a delightful green; they invest the rocks of the waterfall with a coating of various hues; and they cover our garden walks and the roofs of our houses, during the rainy season, with a carpet of green.

All of these delicate and minute forms of vegetable life, together with the fungi, require a microscope for their study, and when observed under the lens they will be found to present pictures of surpassing beauty.

Cook's *Fresh-Water Algæ*, London, is a beautiful but costly illustrated work which treats the subject comprehensively.

LICHENS.

[BY DR. H. W. HARKNESS.]

Of these plants we have a large number of species, but few of which have been carefully studied. Many of these are showy and lovely objects; perhaps the most prominent is the *Evernia vulpina*, the familiar sulphur-colored lichen which attaches itself to the trunks and branches of trees in the Sierra Nevada mountains. Still another, of a gray color, hangs in festoons from the oaks of our valleys, while several others attach themselves to the fences in the vicinity of the sea-shore. Many, and indeed all of these, will well repay thorough study; and several of them are useful as furnishing valuable dyes for coloring cloth.

The best authority on lichens, in the world, is Professor Tuckerman, of Amherst, Massachusetts; and this ardent scientist has for years been in the habit of freely identifying specimens sent to him by young students in all parts of the world.

CONCHOLOGY.

There are probably few branches of natural science which offer so fascinating a field of study as that of shell-collecting. The almost infinite beauties of form and coloring presented, the strange hiding-places sought by the little creatures which inhabit the shells, the wonderful intelligence often exhibited by these Lilliputians, invest the study with a rare fascination. We read in a bewitching old book, which is held in high esteem by modern shell-collectors, that these tiny shell inhabitants possess singular and interesting characteristics. Some of these strange little beings are cannibalistic, and even wage war upon their own relatives. When the bivalves shut close together and the warrior is debarred from crossing his enemy's threshold, his sharp little teeth file a hole through the shell; and in fossil-shell beds, it is said, nearly half of the bivalves and sea snails are perforated—grim evidence of antediluvian banquets. They are also capable of self-sacrificing deeds of friendship. A distinguished naturalist records an instance where a Roman snail, escaping from a garden, returned in search of his fellow-prisoner, and together they set off to enjoy their new-found liberty. The little new-born progeny sometimes shelter themselves for a time beneath the protecting shell of the parent, and even spin silken threads by which they moor themselves

to avoid being drifted away by tide or current. The parental instinct, too, is nobly developed in some species. One tropical mollusk cements leaves together to protect and conceal its large bird-like eggs. Slugs bury their eggs in the ground. The oceanic snail attaches her eggs to a floating raft, and the beautiful argonauta carries them in her frail boat. The river mussel goes further in her parental devotion, and nurses her young in her own mantle or pouch.

A singular feature of shell-collecting seems to be that nearly every one who adopts the pursuit begins by gathering sea shells, and as invariably concludes by becoming a most enthusiastic collector of land shells. This is partly due, no doubt, to the greater facility with which the latter are found, and also to the better opportunity afforded for observing their habits. Occasionally scientific men become attached to these little animals, and preserve them alive. I once came into possession of a specimen of helix (or common snail) which boasted a very wonderful and eventful history. It was a renowned traveler, and was originally picked up in Australia, by an English tourist, who had carried it once around the globe and then brought it to San Francisco, in the bottom of his big trunk. He presented it to a conchologist on this coast, who was accustomed to carry it in his vest pocket when he went out "shelling," as he called it; and when he sat down to rest he would take the little creature out of his pocket and let him browse on the leaves and green things around him. I am not sure but he used him as a decoy to attract other snails; but, at all events, after the snail had been in his possession six months he in turn presented it to me. We grew to be very fond of

the wee thing, and the children were always delighted when he was placed upon their hands and slowly put his head out of his shell and ran out his horns, in seeming obedience to their call, or contentedly devoured the fresh leaves they brought him. He was a small glutton, who had feasted like an epicure in almost every land on earth, and he wintered with us in Los Angeles, coursed over the southern plains, ate up the only three blades of grass in a New Mexico garden, crossed the Rocky mountains, and rejoiced for a brief season amid the luxuriant vegetation of a northern Wisconsin summer. When cold weather came, he drew a thin filmy curtain over the mouth of his shell and went into winter quarters. No amount of coaxing or of warming would call him forth, not even when we tried to deceive him by placing him among some winter house-plants. He was shut up in a drawer, and forgotten until late in spring. When all nature was abloom again we took him out, with dread and contrition. The delicate curtain was rent, and he had shrunk back out of sight in his shell, which emitted a fetid odor. We placed him tenderly beneath a raised wooden walk in the back yard, meaning later to give him decent burial; but when we went out to find him he was gone, and a slimy trail over the grass told that he had started again upon his journey. His course was due north, and so great is our faith in his enterprise and love of travel, that we do not doubt he has by this time penetrated to Arctic regions and possibly solved the mystery of the North pole.

The earnest and intelligent student can not regard his shells as he would so many coins or rocks or plants, but

feels that he is preserving the deserted palaces of a fairy race.

INSTRUCTIONS TO COLLECTORS.

The Rev. Joseph Rowell, one of the best informed conchologists upon this coast, and whose collection of shells, comprising many species, has but two or three rivals among private collections in America, has kindly contributed the following notes, the condensed result of long years of observation and of experience.

MARINE SHELLS.

The following is a list of those found in San Francisco harbor:

Limpets (patellæ)—Are small, flat shells, and Littorinæ are small, cone-shaped shells, with a mouth at the large end. They are found everywhere, on piles and rocks, at low tide.

Teredo—Is a long string of jelly, with sharp-edged bones for a mouth. It is found in pieces of old piles that have been taken out of deep water.

Tellinæ—Are small, flat bivalves, which abound in mud and sand, on Oakland flats, Mare Island, etc.

Cardium—Is a large, ridged bivalve, and is found in sand above Hunter's Point, and elsewhere.

Barnacles (balanus)—Are found on ships' bottoms, piles, etc.

Policipes—Are small, white shells, with many over-lapping valves, and are found attached to rocks by a muscular stem.

Pholas—Is a multivalve, and is found within hard rock at Black Point.

Saxicava—Is a small, rough bivalve, and is found among rocks at Black Point.

Machæra—Is a long, narrow, flat, shining bivalve, and is found on the beach near the Cliff House.

Cryptomya—Is a small, white bivalve, with a brown skin, and is found in mud and sand among rocks off Black Point, and elsewhere.

Macoma—Is a small, white bivalve, with roundish valves, and is found on the shore of Mare Island.
Mera—Is spotted with red, and has small valves, and is found on the beach near the Cliff House.
Mactra—Is a large, thin-shell clam, and is found deep in sand on the Oakland flats.
Tapes—Is a hard-shell clam, and can be had at a fish-market.
Pectunculus—Are found on the Farallone islands.
Mytilus—Mussel, found in market.
Ostrœa—Oyster, found in market.
Other small bivalves are found with saxicava.
Chiton—Is a shell with eight overlapping plates, and is found attached to rocks.
Columbella—Is a small univalve, and is found in mud among rocks.
Fissurella, "keyhole shells"—Are found with patella, but deeper in water.
Mitra, "Bishop's cap"—Is found on the Farallones.
Chlorostoma—Is a snail-shaped shell, black or brown in color, and found off Black Point. Modulus also.
Purpura—Is a small shell, found under stones off Black Point.
Other small shells are found in mud and sand among rocks on the beach near the Cliff House.

LAND SHELLS—FOUND NEAR SAN FRANCISCO.

The most common of all California land shells is the Helix—the shell-bearing snail. All snails are closely hidden away in dry weather, but crawl about in wet seasons.
H. Nickliniana and H. redimita—Are a half inch in diameter, and more. Found in San Francisco and adjacent regions. They are found in moist places, under low bushes, boards, etc.
H. vincta and H. Californiensis—Are found in Pacific Grove, Monterey.
H. ramentosa—Is found at Mare Island and in Contra Costa county.
H. exarata—Is found at Santa Cruz and in San Jose valley.
H. Columbiana (Aplodon)—Is small, and found from Santa Cruz to Gualala.
H. sportella (macro-cyclis)—Is a flat, white shell, and found from Santa Cruz to Gualalla.
H. loricata (triodopsis)—Is quite small, and brown, and found in places same as the two above.

H. Dupeti-thuarsi—Is three quarters of an inch in diameter, bright and striped, and found at Monterey.
H. arrosa—Comprises several varieties, and is found from Santa Cruz to Novarra.
H. fidelis—Eureka, and north and south in that vicinity.
H. infumata—Is an inch and more in diameter, is smoky, and flat, and is found in hollow trees and dark holes, in Contra Costa, Marin, and Sonoma counties.
H. arboretorum—Is large, and found on Cape Mendocino.
H. nemoravaga—Is large also, and found near San Rafael.
H. couspecta—Is very small, and is found under leaves in Lone Mountain cemetery.
H. Duranti—Is very small, and found under leaves at Haywards.
Pupa (pupilla) Californica—Is found in rotten wood in the sand-hills.
Pupa (pupilla) Rowellia—Is found in rotten wood at Temescal, also in wet moss on oaks near Redwood.
Succinea—umber color—Is found on grass in swamps, and on borders of lakes.

COLLECTING MARINE SHELLS.

The collector will find it advantageous to be provided, if possible, with the following articles: An oblong basket, with a bail handle, and a cover at each end; some small wooden or metal boxes; some vials; a hammer and cold chisel, for pholas, etc., which must be used very carefully, in order to not injure the shells; a small butcher-knife, for patellæ, etc., though a pocket-knife will answer; water-proof boots, and stout, old clothing. Large shells must be kept separate from small ones, and frail shells apart from hard ones. The vials are designed for smal shells.

Outside of San Francisco harbor, both north and south, grow numerous other species of shells. Various fresh-water shells are found in Mountain lake, near the Marine Hospital, in Lake Merced, and other lakes in this vicinity;

and in all stagnant and most moving waters. These are all very frail.

To extract the animal from the shell, the best way is to cook the animal, but not too long. Some experience is needed to kill and condense the animal and leave it tough, so it may be drawn out with a sharp, slender, crook-pointed shoemaker's awl, skillfully twirled to conform to the whorls of the shell. This refers particularly to univalves. If a small portion of the animal remains in the shell, it will soon dry up in the California air.

A little sweet or nut oil, applied with a camel's-hair brush, will make dull shells brighter, and will keep frail shells from cracking in dry weather. Do not varnish them.

GATHERING LAND SHELLS.

To collect land shells, no tools nor accouterments are needed save a few tin or wooden boxes, ranging in size from a half-pound yeast-powder box down to smaller dimensions, and a few small vials. All these should be stowed away in ample pockets. Remember that land shells are generally very frail, and therefore must be handled carefully. It is well to place the different kinds in separate boxes. As most of the land shells are small, sharp eyes, patience and skill are needed, the latter being acquired only through practice. The animals are removed from the shells in the same manner as those of sea shells, but require more delicate care.

The collectors who desire to prosecute their studies with an intelligent guide, will find Keep's the best authority upon the sea shells of this coast, and in it will find the best aid to the study of the land shells of this state.

ENTOMOLOGY.

[BY DR. HERMANN BEHR.]

No branch of Natural Science presents such a wide and interesting field for study on this coast as that of Entomology. It is roughly estimated that ten thousand known species of insects are found in this vicinity, and that fully ten thousand more still remain to be identified or named.

Aside from the discoveries to be made and the honors to be achieved in assisting in the classification of this vast tribe of Liliputian strangers, a study of their habits, their varying characteristics, their methods of procuring subsistence, their habitations, and manner of rearing their young, as well as their curious social intercourse, opens a fascinating field of inquiry. Some insects, like the bee, the wasp, the hornet, and the ant, are socialists, and live in an advanced stage of civilization, with a perfect code of government and admirable penal laws. Others lead a vagabond existence, living from hand to mouth; and for this latter class the salubrious climate of our state must offer a delightful refuge. Others still are wonderful travelers, and flit through the air or journey over the ground for long distances. They are sometimes pests and sometimes blessings; but it is certain that a more intimate knowledge of them would diminish their annoyances in

the one case, or increase our appreciation of their services in the other.

METHODS OF COLLECTING INSECTS, SPIDERS, AND CRUSTACEA.

The implements required are a butterfly net, a sack fastened to a stick, to be drawn through the grass; a strong stick to knock against branches, and an umbrella, to be placed underneath the branches, to receive the falling insects.

In handling *hymenoptera* (wasps, bees, hornets), the collector had better protect the hands with gloves.

Most insects have to be collected on flowers and leaves. Beetles are most frequently found underneath stones, logs, dried dung, in carcasses of dead animals, and in toad-stools. Spiders are found in greatest abundance on fences or about wooden walls. Crustaceous animals (wood-lice, shrimps, etc.), in water or moist places.

TREATMENT OF SPECIMENS.

Spiders, crustacea, and under some circumstances beetles and bugs, may be preserved in alcohol. Most of the insects are best killed in a poison-glass, which is a jar or bottle with a glass stopper, in whose bottom a piece of cyanide of potash is fastened down with a coating of gypsum, through which the poisonous fumes of the deadly chemical readily find their way. On account of the dangerous character of cyanide, the preparation of this bottle must be left to the druggist. It is necessary to always handle the bottle with great care, and when carried out on excursions it must not be placed in the same pocket or case with the lunch.

Butterflies, wasps, flies, darning-needles, bugs, grasshoppers, and *cicadæ* are best wrapped singly in envelopes, and are either pinned to a card immediately after returning home or are left in the paper, to be used for exchange with other entomologists. In this latter case, the name of the insect must be written on the paper. Beetles, wasps, flies, etc., have to be prepared by expanding their wings on a piece of wood. This can be done only while they are still soft; and they must remain in this position until they are dry, when they can be removed and put into place in a collection. Caterpillars and other larvæ are taken home alive and fed with the leaves of the plant on which they have been found. Fresh leaves must be provided every day. On the ground of the box must be placed some sawdust, for the benefit of the caterpillars, which hide in the ground for transformation.

ORNITHOLOGY.

[BY E. F. LORQUIN.]

Among the many branches of natural history which attract the attention of the lover of nature, one of the most interesting, and full of enjoyment, is the study of ornithology. The grace, lightness and beauty of many of the feathery families, their interesting habits, sweet songs and gentleness, their susceptibility to education, and last but not least the delicate flavor of the flesh of many, have given them the first rank among the pets which adorn our homes and the delicacies which supply our tables. Their capture, either by trapping or by the more expeditious method of hunting, affords the sportsman pleasure, exercise, and an opportunity for breathing the pure and exhilarating air of the country. It is not, therefore, surprising that the study of birds has been among the first branches of natural history which have attracted the attention of naturalists.

Birds are distributed over all the different countries of our planet, even the most desolate spots having their share of the feathery tribes, who visit them during the summer months. Some portions of the earth, however, are more favored than others, and the tropical regions of Central and South America, the Philippine and Molucca

islands, New Guinea, Australia, India, and Africa, are tenanted by countless flocks of gorgeously plumaged birds, while the frigid wilderness of Alaska, Siberia, northern Europe, Iceland, Newfoundland, Patagonia, and the islands situated to the south of Cape Horn, are the abode mostly of sea-fowls, such as ducks, geese, albatrosses, petrels, penguins, gulls, and divers.

The temperate countries, although less favored in regard to color than the tropical regions, can boast of a greater variety of species and families, for, beside their own indigenous residents, they are the wintering quarters of the more northern tribes and the summer resort of birds who inhabit more southern latitudes. Among the birds of temperate countries are also found the sweetest songsters, such as the nightingale, the linnet, the lark, the thrush, and many of the warblers and finch families.

The great diversity of temperature in the different parts of our state, its immense stretch of sea-coast, its great lakes, interminable plains, lofty mountains and dense forests, have given California, by diversifying the conditions of existence and producing a great variety of food, a very large share in the distribution of the denizens of the air. In this state are found not less than three hundred different species of birds. The hawk family numbers at least twenty species. We have ten owls, two jays, five species of humming-birds, twelve species of woodpeckers, twenty different kinds of ducks, two pelicans, seven species of herons, an immense variety of gulls, terns or sea-pigeons, and cormorants, half a dozen thrushes, about fifteen warblers, a great many fly-catchers, and twenty finches, beside many others whose enumeration would take too much space.

Birds caught in traps can be either chloroformed or simply smothered, by seizing them, if they are small, under the wings, between the thumb and forefinger, and compressing the lungs, when they die in a few moments, without much pain. When shot, the wound should be covered with plaster of Paris, or if that is not at hand, fine dust from the highway, so as to stop the blood. Then the bill and nostrils should be stopped up with cotton, to prevent the escape of liquids contained in the stomach. Each bird should be wrapped up separately in paper, and carried in a basket or botanical box, for if laid in a bag they become soiled by the blood escaping from the wound, on acccount of the pressure exercised on each other.

In order to skin a bird, the specimen should be laid on its back and an incision made along the breast bone; then by using the flat-end of a scalpel, the skin can be separated from the flesh and turned back on one side, until the wing is reached. This can be cut under the skin with a pair of curve-blade scissors, when the same operation can be performed for the other wing. The neck should then be cut off, and the head left hanging toward the tail; while the skin is gradually detached from the body of the bird, until the tights are reached. These should be cut at the bone joint, as the wings have been, and the skin brought down to the root of the tail, when it can be readily detached from the body, leaving only the members and head to be cleaned. For this purpose the legs and wings are detached from the skin, pulled out, and all the flesh removed from around the bones, which are then, as well as the skin, covered with preservative and returned to their places. The head is then turned over, by seizing the stump of the neck with the fingers, detaching the

skin from it, and drawing it out toward the bill, baring the skull. The eyes, tongue and brains, and all muscles, should then be removed, the fat remaining on the skin scraped off and well absorbed with plaster of Paris, and the whole skin treated to a good coat of preservative. Then, if the specimen is intended for a cabinet skin, the eye cavities, throat and skull should be filled with cotton, the skin drawn back over the skull, the neck and body filled up in their turn, the incision sewed up, and by a little manipulation the proper shape restored to the subject, when it can be laid on a shelf until dry.

If the bird is to be mounted, the eyes alone should be filled with cotton, and the rest of the body, including the head and neck, should be stuffed with oakum or tow, cut fine. Then a wire, a little longer than the bird, including tail feathers, and of a thickness proportionate to its size, is doubled up and bent over, so as to make a small loop in the center, the ends prolonged in opposite directions so as to make a continuous straight line, and one end inserted in the tail of the bird. Another wire, sharp at one end, is then thrust through the skin under each foot, run along the leg, under the skin, and finally brought out through the loop of the central wire, when the three wires are firmly twisted together. The loose end of the main or central wire is then bent back, carried along the inside of the neck, and through the skull and skin, coming out between the eyes. The legs are then stuffed, by twisting cotton-batting around the bones, the filling of the body completed, the skin sewed up, and the limbs set in a proper position.

A stand having been procured, two small holes are drilled in it, and the wires coming out through the feet are

passed through these holes and turned around the stand, so as to keep the bird firm on its feet. Then the head, neck and body must be set in proper attitude, the wings secured in their proper places with pins or needles, artificial eyes placed in the sockets, and, after securing the whole with either thread or fine twine wound around the body, or a piece of cloth secured with a needle, the bird is allowed to dry in the shade, and can be inspected from time to time, in order to alter it or smooth the feathers.

This is the process in favor with most of the museums of Europe, and particularly the Jardin des Plants of Paris, and the one I have satisfactorily employed for upward of thirty years in this city. There are other processes which it would take too long to detail here, and which it is needless to explain, inasmuch as this, in my opinion, is the best.

Preparing and mounting small specimens of birds is a very interesting and agreeable pastime, even for ladies, and requires but a small outlay in tools and material, of which I append a list.

Tools—One scalpel, two pairs forceps, two pairs pincers, one brain-scooper, one file, one pair scissors, one pair nippers, one preservative brush, needles, pins, thread, etc.

Materials—Wires of different sizes, cotton-batting, oakum or tow, preservative, artificial eyes.

OÖLOGY.

The study of nests and eggs may be regarded as an almost necessary supplement to the study of Ornithology. As no competent person has been found to volunteer a paper upon the subject, and it seemed unjust to trespass further upon Mr. Lorquin's kindness, the editor of this little book will make a few observations, based upon her own slight knowledge.

The true naturalist can never be content with results alone. It is not enough that the blossoming plant stands before him in all the beauty of maturity; he goes back to the seed and to the soil, and traces its development, stage by stage. The pearly tints and exquisite forms of the shell only arouse his interest in the tiny creature whose abode it forms, and which he traces back to the little transparent globule buried beneath the soil or cradled on the waters of the deep. So the collector of birds does not rest content with the handsome specimens mounted in his cabinet; but he finds a broad and fascinating study in observing their habits, becoming familiar with their notes, and, above all, in acquainting himself with their methods of nest-building, the appearance of their eggs, and manner of rearing their young.

The study of nest architecture is charming in itself. No two species of birds build their nests alike, and many of

the latter, notably the hanging nest of the oriole, are woven with great skill and ingenuity. It requires much patience and sharp watchfulness to discover the location of a nest, and it must be remembered that of the three hundred or more birds which annually visit our neighborhood, only a small percentage breed in this vicinity. One curious fact which will soon attract the notice of the student is, that with but few exceptions birds of conspicuous colors build concealed nests, while in species where the plumage of the female is dull the nest is fully exposed.

The humane collector who discovers a nest which is not at too great a distance to revisit, will content himself with removing only a couple of eggs, and wait to secure it at the end of the breeding season. He can pursue this considerate policy the more readily in our state, as the breeding season usually commences only after the close of the heavy winter rains, and there is little danger that the nest will become sodden or spoiled. The eggs should be emptied by making a small orifice with a pin at each end, and blowing out the contents. The empty shells are extremely fragile, and if kept apart from the nest can only be safely preserved in small pasteboard boxes filled with cotton-batting, until the collection has attained sufficient size to justify the purchase or manufacture of a small cabinet. Properly classified and labeled, such a collection is both interesting and beautiful; while the nests present an important study, not only on account of their remarkable architecture but also because of the singular materials employed in their structure.

ICHTHYOLOGY.

[BY WILLIAM E. G. HARFORD.]

The study of fishes can only be pursued to advantage on the sea-coast, where a multitude of finny forms can be procured for observation with a trifling outlay of time and trouble. Into the great markets of San Francisco, at one time or another during the year, are brought a large proportion of the six or eight hundred species known to exist along the coast of the state; and the collector who wishes to economize his time naturally turns to these places as the most available fields of study. It is an obvious advantage to see the fish as soon as possible after it comes from the water, and before the various kinds are assorted on the counters and begin to find their way into the possession of buyers. Twice a day, at hours easily to be ascertained from the fishermen, the "catch" of the seines are brought into the market, and the student or collector who is promptly on hand can not only be sure of securing all of the common species but many of considerable rarity, with a good chance of stumbling across a specimen altogether unknown to science. A still better plan is to go to the places where the fishermen cast their nets, when accessible, for a great many small fishes and curious things brought up by the seines from the sea or

bay are carelessly dumped upon the beach, and never find their way to the market. In passing, it may be observed that Messrs. Jordan and Gilbert, of the Smithsonian Institute, who a few years ago astonished students of ichthyology all over the civilized world by the great number of new species they discovered on the Pacific coast, depended largely upon the markets and the fishermen to supply them material for observation.

Each of the smaller towns along the coast usually has its Italian or Chinese fishermen, and the same plan can be pursued to advantage there. The *Cyprinadæ*, a large family, comprising the carp, spotted shiner, river chub, the so-called "Sacramento pike," and many other well-known species, are all fresh-water fish, and can be taken with hook and line from the streams up and down the coast.

There are three ways of preserving fishes for scientific use and observation. The one most commonly employed by the collector is to place the specimen in alcohol. After reaching home the fish should first be washed with fresh water, to remove the slime, and then be placed in alcohol diluted with one third the quantity of water. After it has remained in this solution for ten or twelve hours (and it may be remarked, parenthetically, that this mixture should be kept, for economy's sake, for the reception of other specimens) it should be put into a stronger solution for a short time, and can then be placed in a large glass jar filled with pure alcohol, and closed with a ground-glass stopper resting on a rubber ring and fastened down with a clamp. It is necessary to introduce the fish to the pure alcohol by degrees, because if placed in it at first it will harden too suddenly and present a shriveled

appearance. One unforunate result no one has ever discovered the means to prevent—the beautiful colors which characterize the living fish invariably fade out, leaving the specimens dull and plain. Another simple process, which is inexpensive—and if done carefully and skillfully leads to quite satisfactory results,—is to simply skin the fish. This can be done by cutting the fish through the middle and parallel to the back bone, saving the dorsal fin and the ventral fin, and then carefully removing the skin and placing it between heavy absorbent paper, to dry beneath heavy weights, as one would press a succulent plant. When the process is at last completed, the entire surface of the skin is covered with a coat of light varnish, and it makes a very pretty object for a museum.

The third process is very difficult and laborious, demanding great skill and consuming much time. It consists in skeletonizing the fish, removing all the skin and flesh and outer portions, preserving the skeleton intact. There are only a few collections of this kind in the world, and no one upon this coast has ever attempted to prepare specimens in this manner.

Woodward's Garden, with its large glass tanks, presents an interesting and advantageous point of observation for those who wish to study the characteristics and habits of the living fish.

Many curious facts will come to the knowledge of the student. The most prosaic and minute forms of animal life have romances and tragedies to unfold. The fish of our coast have one relentless and insidious foe. This is the little *myxine*, or hag-fish, a member of the family *myxinidæ*, which is a genuine cannibal, and bores its way through the sides of large fish, subsisting upon their

flesh until they yield up their lives to its death-dealing ravages. It is especially fond of the rock cod, and specimens of the latter fish are sometimes found which are literally reduced to skin and bone, while the villainous little *myxine* is discovered snug and fat in its ghoulish abode.

Some of the rays (a species of fish belonging to the same great group with the sharks) have eggs which look like a transparent oval pod filled with fluid, and have a long filament attached. These curious ova become entangled with sea-weed, and are often floated up on our beaches. Any one fond of experiment can take the egg home and place it in a bottle of salt water, and before many days have elapsed a little form will be seen squirming and wriggling within the egg. No one has ever succeeded, to our knowledge, in carrying the hatching process further; but it is quite within the bounds of possibility to procure for the home aquarium a young ray of one's own raising.

The most beautiful fish in the world is found in Monterey bay. This is the opah, technically called the *Lampris*, a species of the *guttatus*, sometimes also called the kingfish, sunfish, etc. It is a large round fish, almost circular in form, frequently measuring as much as two and a half feet across. Its prevailing colors are a rich brocade of silver and lilac, rosy underneath; the head, opercules and back aglow with ultramarine tints; the jaws and fins vermilion. Seen in the water, and especially in the sunlight, it is a never-to-be-forgotten sight.

It is greatly to be regretted that San Francisco has no great sea-water aquarium in which to exhibit these wonders of the sea. The establishment of such a place would not only result in diffusing a wider knowledge of such matters among our own people, but it would attract

visitors from far and wide. The greatest aquariums of the world are at the Zoölogical Station in Naples. During the lifetime of Agassiz he maintained aquariums on the island of Penikuse, and there are now three biological stations on the Atlantic coast—one established by Alpheus Hyatt, at Green bay, Mt. Desert; another inaugurated by an enthusiastic scientific gentleman, on the three hundred and-sixty-fifth of the Thimble islands, in Brantford bay, Connecticut; and the Chesapeake Biological Laboratory, at the Johns Hopkins University.

The Pacific coast, with its magnificent range of marine curiosities and almost countless varieties of fish, offers a splendid field for a speculator of a biological turn of mind, while the man of wealth, who wishes to add to the attractions and increase the educational advantages of the city, could take no wiser step than to establish a mammoth aquarium.

MINERALOGY.

Young persons who are ready to become earnest students of this interesting branch of science will find dozens of hands stretched out to aid them. California is particularly rich in the possession of skilled mineralogists, for the varied geology of the state not only offers a broad and fascinating field for the enthusiast, but practical necessities connected with the investigation and development of valuable mineral deposits have drawn hither men of the highest repute and most thorough training. During the last ten years their number has been increased by the accession of special students who have received a theoretical education in our schools and under private tutelage, and whose knowledge has ripened in the school of experience.

Mr. Melville Atwood and Mr. Louis Falkenau, two gentlemen widely known as expert mineralogists, have kindly furnished the editor with some simple and practical suggestions for the guidance of inexperienced collectors.

The first important requisite for the young student who desires to take the field is to have a sufficient number of pockets; and for this reason nothing is so well adapted to a tramp through the hills in search of specimens as an ordinary shooting-jacket, made of stout canvas, and

with any number of places in which to stow away lunch, drinking-cup, implements, specimens, etc. If any wise mother desires to encourage her young daughter to join her brothers in an invigorating pursuit, I advise her to provide the young girl with a neat, tasteful jacket, of some stout dark cloth, as plentifully provided with pockets as the shooting-jacket, and see if the little woman is not happy for once in her life.

As it is advisable to carry as few and as light implements as possible, a small steel hammer, terminating in a hard chisel, and attached to a long stick, which can be used as a staff, will be found a most convenient and useful tool. It has the advantage that it can be employed to tap an outcropping of rock at a considerable height; but this is partially offset by the awkwardness of handling it when the rock to be broken is close at hand. If the handle could be made so as to screw together at a point about a foot from the head, or if the cane could be made hollow and the hammer of the handle inserted at the top, the advantages of the long and short handle could be combined. A small canvas bag, of home manufacture, which can be rolled up and stowed in small compass when not in use, is a convenient receptacle for lunch or specimens; but older persons will find that nothing answers every purpose so well as a stout knapsack, which can be strapped across the shoulders, leaving the arms and hands free for climbing. Mr. Falkenau informs me that he has carried seventy-five pounds of specimens across the Alps, in a knapsack of this kind. Among the tools required in breaking up the rock, a small hand-chisel is an almost indispensable requirement, especially when there are fragile forms or fine crystallizations to be loosened from the hard rock in

which they are frequently imbedded. Collectors who have arrived at years of discretion will find it advantageous to carry with them, on their out-of-town trips, several simple acid preparations, by which the presence or absence of certain minerals is easily ascertained.

In regard to the size of specimens for a cabinet, Mr. Falkenau says that in the case of crystals they should of course be obtained of as great size as possible; in amorphous or uncrystallized rocks the size of the specimen is purely a matter of taste, but it should be large enough to show the character and color clearly. It is better to have small specimens well stored than to have large ones and no decent place to put them.

The method of arrangement and classification of mineral specimens is usually a difficult and troublesome question, for if numbers are attached to the rocks themselves they are always being rubbed off, and even large, flat cards are in danger of being displaced. Mr. Falkenau offers an ingenious and inexpensive solution of the problem. He recommends procuring small, square pieces of tin, which can be obtained from a tinner at little or no cost, and cutting slits at each corner, so that the sides can be bent upward and inward, thus forming little trays. The label should be pasted securely to the bottom. No jar or careless movement will displace the specimens, and if it becomes necessary to pack them, each can be taken up in its own little tray.

For examining specimens, the first and most important requirement, as in almost every other branch of the natural sciences, is a small hand-glass, which costs from fifty cents to a dollar. To simplify and expedite the examination of specimens, Mr. Melville Atwood declares

that no ordinary process is of such great assistance as to have one face of the specimen ground off and polished. The polished surface shows the most delicate markings and colorings, and in the case of crystallized specimens shows the form of crystallization. Mr. Atwood also suggests a very simple and inexpensive process of polishing specimens, which can easily be conducted by a child, and will afford occupation and amusement. The specimen should first be roughly ground off on one side by holding it against a grindstone. It should then be placed in a shallow vessel filled with water, and, holding it beneath the water, it should be rubbed with several grades of whetstones, gradually progressing from a coarse grain to the finest quality, and finishing with an emery file. All of these little accessories can be procured, at small cost, from a hardware merchant; and Mr. Atwood has in his cabinet specimens polished in this manner which show as beautiful a finish as if they had come from the hands of a skilled lapidary.

The region in the immediate neighborhood of San Francisco, though especially interesting in a geological way, presents little variety in the way of mineral deposits. There are probably not more than a dozen distinct varieties of minerals in this vicinity, and few of these are especially interesting or beautiful. The San Francisco collector is, however, most advantageously situated if he desires to found a large and valuable cabinet. The entire mineral deposits of the state are tributary to San Francisco, and miners from the most remote mountain districts are continually traveling back and forth between the city and their camps. It is very easy to arouse their interest and to procure choice specimens from the mines

they represent. A copy of a city daily sent to these lonely camps now and then, or some readable literary paper like *The San Franciscan*, will be sure to enlist the interest and good-will of these patient workers, and insure a rich return to the young collector.

Students who go on summer trips to the country will have special facilities for collecting, and, by keeping their eyes open, may obtain some rare and valuable specimens. It is well to remember that there is a dual object in collecting. The direct benefit to the cabinet is always the leading thought, but there is another and no less important consideration. A plentiful quantity of duplicate specimens should always be procured for the purpose of exchange. California specimens are a rich medium of exchange for mineralogical specimens throughout the civilized world.

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